Vol. IV. MARCH, 1888. No. 11.

American Meteorological Journal.

A Monthly Review of Meteorology, Medical Climatology, and Geography.

TABLE OF CONTENTS.

ORIGINAL ARTICLES: PAGE

The Organization of the Meteorological Service in Some of the Principal Countries of Europe. A. LAWRENCE ROTCH.. 497

A Classification of the Winds. WILLIAM MORRIS DAVIS..... 512

The Pontotoc Meteor. COL. R. BOLTON..... 520

Pressure and Temperature in Low and High Areas. H. ALLEN HAZEN.. 527

CURRENT NOTES:

Air Temperatures. A. L. M..... 530

Air-Pressure and the Moon. A. L. M..... 531

The Logs of the Great Raft..... 532

Icebergs and Field Ice..... 532

The Application of Photography to Meteorology. A. L. M..... 534

Submarine Oil Springs..... 536

Abercromby's "Weather." H..... 538

Royal Meteorological Society..... 541

ANN ARBOR, MICH., U. S. A.:

METEOROLOGICAL JOURNAL COMPANY.

19, 21 and 23 Huron Street.

F. A. BROCKHAUS, Leipsic, Berlin, and Vienna, Agent for German and Austrian States.

Single Copies, 25 cents. Per Annum, $2.00. In European Countries, $2.25.

Entered at the Ann Arbor Postoffice as Second Class Matter.

AMERICAN METEOROLOGICAL JOURNAL.

AN ILLUSTRATED MONTHLY

DEVOTED TO SCIENTIFIC METEOROLOGY AND ALLIED BRANCHES OF STUDY.

THE AMERICAN METEOROLOGICAL JOURNAL CO., Publishers and Proprietors,
Ann Arbor, Michigan.

M. W. HARRINGTON,
Director of the Astronomical Observatory, Ann Arbor, Michigan,
A. LAWRENCE ROTCH,
Proprietor of the Blue Hill Meteorological Observatory, Massachusetts.
Editors.
KITTREDGE & HOLMES, Managers.

PRICE,—IN THE UNITED STATES, - - - - $2.00 per year
" IN COUNTRIES OF THE POSTAL UNION, - - 2.25 " "

Agent for German and Austrian States
F. A. BROCKHAUS, Leipsic, Berlin and Vienna.

The editors solicit communications on all subjects having any bearing on Meteorology, Climatology, or American Geography. Correspondence on events of current interest is invited, and accounts of local newspapers concerning them will be welcome. Notes on local climate will be published and the columns of the JOURNAL are freely open for worthy communications on all matters within its scope. The editors do not hold themselves responsible for any communications which may be signed or attributed to other authorship than their own. Address all communications to

AMERICAN METEOROLOGICAL JOURNAL CO.,
Ann Arbor, Mich.

THE UNIVERSITY OF MICHIGAN.

More than 80 Instructors.

A LARGE AND CHOICE LIBRARY

Freely accessible to Students.

Its various departments of Physical Science, Biological Science and Engineering are thoroughly manned, and are provided with Laboratories, Observatories, Museums, Special Libraries, and Workshops.

It was the first Collegiate Institution in America to establish a special course in Meteorology.

Greatest possible Freedom in Studies allowed.

Fees very moderate. For further information address

JAMES H. WADE, Secretary,
ANN ARBOR, MICH.

THE AMERICAN
METEOROLOGICAL JOURNAL.

VOL. IV. ANN ARBOR, MARCH, 1888. NO. 11.

ORIGINAL ARTICLES.

THE ORGANIZATION OF THE METEOROLOGICAL SERVICE IN SOME OF THE PRINCIPAL COUNTRIES OF EUROPE.

BY A. LAWRENCE ROTCH,
Member of the German Meteorological Society, and Fellow of the Royal (London) Meteorological Society.

Introduction—These articles are based upon a similar series by Dr. G. Hellmann (*Die Organization des meteor. Dienstes in den Hauptstaaten, Europas*), which was published in the *Zeitschrift des k preussischen statistischen Bureau* in 1878 and 1880. The headquarters of the services were visited by the present writer in 1885 and 1887, and the changes which had occurred noted, while several bureaus unnoticed by Dr. Hellmann are included in the following articles. In addition to the above material, the writer would acknowledge his indebtedness to the work of M. Hepites (*Serviciulu Meteorologicu in Europa*), and to the reports of the committees appointed by the Congresses of Vienna and Rome. He wishes also to express his appreciation of the courtesy shown him by the directors of the various services, and especially to Dr. Hellmann, who has promised to read the proofs of the articles describing the Continental services, and to R. H. Scott, Esq., Secretary of the English Meteorological Office, for a similar favor for that country.

GERMANY.

Organization.—The meteorological service in the German Empire is carried on by different systems, which are connected

with each other, and which are limited by the political divisions. The organization of the *Deutsche Seewarte* is the only one which is imperial, and in this respect extends over the whole Empire. It is the central office for maritime meteorology and for weather telegraphy. The other systems which work in coöperation with the *Seewarte* are:

1. The Kingdom of Prussia and the smaller states which combine with it, such as Mecklenburg, Oldenburg, Saxe-Coburg, etc.
2. The Kingdom of Bavaria.
3. The Kingdom of Saxony.
4. The Kingdom of Württemberg.
5. The Grand Duchy of Baden.
6. The Imperial Provinces of Alsace Lorraine.

The directors of the different central meteorological offices in Germany are accustomed to hold conferences on all questions of importance, the decisions of which are binding on the separate systems, and are accepted as regulations in the organizations of the separate countries.

The system of the *Seewarte* with respect to maritime meteorology embraces the whole German empire. The storm warnings are entirely under the control and management of the *Seewarte*, and extend to the whole of the coast, from the Russian frontier in the east to the Dutch frontier in the west. The weather service, on the contrary, is carried on by the different states for themselves, but in dependence on the *Seewarte*. It consists in the receipt of the greater part of the foreign observations employed in the weather service, which are partly in their original form and partly as results in the shape of synoptic charts and forecasts. Bavaria and Saxony issue their own forecasts, and there are several local bureaus in Prussia for this purpose. Climatological work is not one of the objects of the *Seewarte*, this being attended to by the different meteorological organizations throughout Germany.

THE DEUTSCHE SEEWARTE.

History.—A commission was appointed in 1873 by the Reichschancellor to consider the re-organization of the system of storm

warnings for the German coast. The sum of 54,000 marks was appropriated by the Reichstag for its first cost, and 78,000 marks for its maintenance. Hamburg was chosen as the site of the central office, and Dr. G. Neumayer appointed director.

In 1875 the ships' logs and material of the *Nord Deutsche Seewarte*, established in 1868, were turned over to the *Deutsche Seewarte*. Previous to this a number of foreign weather reports had been received daily in Berlin, published by some of the newspapers, and transmitted to the Prussian sea-ports. These telegrams, with others, were now sent to the *Seewarte*, which reduced them to a practical form for use. The new weather service was commenced in 1876, and the storm warnings, which had been occasionally ordered by Dove, were resumed in 1877.

The Central Office.—There are four divisions of the *Seewarte*.

Division I has charge of maritime meteorology.

Division II has charge of the verification of all kinds of instruments, including those for meteorological purposes.

Division III has charge of the storm signal service and of weather telegraphy.

Division IV has charge of the testing of ships' chronometers in connection with the Hamburg astronomical observatory.

In addition there is a course of instruction for intending teachers at science schools.

The whole system of the *Seewarte* is under the management of a director (Dr. Neumayer), who receives a salary of 10,500 marks and free apartments. Division I has for its chief Captain Dinklage, who receives about 4,800 marks and an allowance for residence. There are three assistants, with an average salary of 2,500 marks each, besides extras. Division II is managed by Captain Koldewey, who is paid as above, and has two assistants. Division III is under Dr. Van Bebber, with an inspector of stations and five assistants, all paid as above. Some specialists, such as Dr. Köppen, the meteorologist of the *Seewarte*, are employed by the office, and the officials in the Administrative Department act for all its branches. The total budget of the *Seewarte*, in 1887, was 226,000 marks.

The central office occupies a fine building, erected in 1881 at

a cost of 2,000,000 marks, on the Stintfang a hill rising from the river Elbe and overlooking the joint cities of Altona and Hamburg. The following are the interior arrangements of the building: In the center of the ground floor is a covered court which contains a rotation apparatus, driven by an engine in the cellar, available for testing anemometers or for giving chronometers the motions to which they would be subjected on board a ship. This court, which can be used for experimental purposes, contains a glycerine barometer. In the basement are the normal instruments and standards of measurements. A regulator clock of Nieberg serves to control all the observations and the clocks of the registering instruments. The normal barometer, by Fuess, is of the cistern-siphon type, with a differential cathetometer. The barometer used in the daily observations is a siphon-cistern instrument by Kupffer, whose readings are 0.02 mm. lower than the Kew standard. The apparatus for testing the meteorological apparatus includes a vacuometer for the aneroid and closed-cistern barometers, and a comparator on Fuess' and Lichtenstein's system for the thermometers. The Combe's rotation apparatus, modified by Neumayer, has a radius of 4 m., and can be used for determining the constants of anemometers at velocities from 0.5 m. to 20 m. per second. In the basement is the baro-thermograph of Schreiber, which records intermittently, upon a revolving drum, pressure by means of a balance barometer and temperature by an air thermometer. There is also a Hipp aneroid barograph, recording electrically. The rest of the basement is occupied by laboratories, the lithographic office, and the janitor's rooms. A long passage leads to an underground magnetic observatory, in which openings permit fixed points, such as spires, to be sighted. The temperature of the room is very constant, and it is here that the ships' compasses are tested. The ground floor contains the rooms of Division II, the collection of models, the instruction rooms, and the director's apartments. In the instrument room, containing reserve and other instruments, is a Sprung-Fuess barograph, whose indications are reduced to the reading of the normal barometer below. In this barograph the tube is suspended from

the short arm of a Roman balance upon which rolls a weight, operated through the medium of a screw by an electric current, which constantly maintains the equilibrium. A pencil attached to the counterweight, inscribes upon paper, shifted in a vertical plane, the variations of pressure independent of temperature. From a north window of the instrument room the ordinary thermometers and hygrometers are exposed in a metallic screen, further protected from the sun by wooden louvres, and from radiation from the room by double windows. The instruments can be read at night, by an electric lamp, without opening the window.

Another thermometer screen in which is a Hipp thermograph, registering by the expansion of dissimilar metals in a coil, is freely exposed in the garden, together with the radiation thermometers and rain gauges. A wooden pavilion for absolute magnetic measurements has been used chiefly to determine the effect of iron, as used in ships, upon their compasses. Another pavilion shelters a photometer for testing ships' lanterns.

In the main building, on the first floor, is the office of the director, a large conference hall, the rooms of Division I, the secretary's office, the reading room and library, which contains about 20,000 volumes including the valuable collection of the late Professor Dove.

On the second floor are the offices of Division III, and the apartments of its chief, with the offices of Dr. Köppen, who has charge of the theoretical meteorology of Divisions I and III. There is also an instrument room containing a station barometer, barograph and an electrical wind register, which permit the changes of the elements to be followed without leaving Division III, which is telegraphically connected with Hamburg.

Above the four corners of the building rise square towers. On the west tower are the anemographs of Osler and Beckley, and a small normal Recknagel anemometer recording electrically. The Fuess anemographs used at the *Seewarte* stations are here compared, and on this tower is the Sprung rain gauge whose indications are recorded below, by weighing a long column of water against a short column of mercury. The precipitation measured

here is about two-thirds of that in the garden. The north and east towers have domes containing, respectively, a universal and a transit instrument. The south tower is used for the testing of sextants, and is open to the public. On the roof of the building, the storm signals are displayed for the shipping on the Elbe.

The Stations, their Equipment and Methods of Observation. —The stations reporting to the *Seewarte* are of the 1st, 2nd and 3rd order; the definition of these classes being that of the Vienna Congress.

The nine normal stations of the 1st order belonging to the *Seewarte* are: Hamburg, Memel, Neufahrwasser, Swinemünde, Wustrow, Kiel, Keitum, Wilhelmshafen and Borkum. These stations are well situated on the shores of the North and Baltic seas, and are especially adapted for wind observations. There are in addition two supplementary stations with an outfit like stations of the 2nd order, which take the same observations as stations of the 1st order, viz.: Cuxhaven and Rügenwaldermünde on the Pomeranian coast. Certain independent stations of the 1st order send contributions to the reports of the *Seewarte.* These are: Magdeburg, Frankfort-on-the-Main, and Kaiserslautern.

The *Seewarte* also receives observations from twenty-five German stations of the 2nd order, partly for the purpose of weather telegraphy, and partly for publication, according to the international scheme.

The forty-five signal stations on the coast are fitted up as observing stations of the 3rd order, and like those of the 2nd order just mentioned, belong to the different systems in the districts in which they lie.

The instrumental equipment of the Central Station at Hamburg has already been described. The normal stations have barographs and anemographs, and a few have thermographs. The superintendents of these stations are paid 450 marks a year, and two being also superintendents of principal marine agencies, receive in addition 2,400 marks.

The 2nd order stations possess the ordinary meteorological

instruments. Both classes of stations observe pressure, temperature, humidity, wind and cloud, at 8 A. M., 2 and 8 P. M., while precipitation is measured at 8 A. M. and 8 P. M. The records of observations are sent monthly to Hamburg, and in addition most of the stations telegraph the tri-daily observations.

All the signal stations have aneroid barometers and thermometers at sea level, which are read at 8 A. M. Wind, weather and state of sea are observed three times a day, and in case of stormy weather are telegraphed at short intervals to Hamburg.

Observations of thunder-storms and hail are made at all the signal stations on the coast, and they report these phenomena immediately after their occurrence to the Central Office at Hamburg, by means of specially prepared cards. The observers, at these stations, like those at the supplementary 2nd order stations, receive 150 marks annually. Whenever it is practicable, the signal stations are either attached to normal stations, or to the marine agencies, in which case the officials receive the accumulated pay. Free postage is allowed by the Government.

The instruments are verified before being distributed to the stations, and in 1885, 1,300 instruments were verified at Hamburg by Division II. A special officer inspects the stations about once a year, and compares the instruments, etc. The director also visits allthe stations about once in two years.

The following is the instrumental outfit of the stations:

The normal stations have a control barometer of the cistern-siphon type, made by Fuess.

The station barometer used for the regular observations has a fixed cistern and a reduced scale which can be read to tenths of a millimeter.

The thermometers are exposed in a zinc screen which is hung 1–2$^{m.}$ distant from a north window, at a convenient height above the ground. The screen has a ventilated top and bottom, and two semi-cylindrical sides which open automatically when it is pulled in front of the window to be read. The screen contains wet and dry bulb, and maximum and minimum thermometers. The latter have forked bulbs, and the former are of the air-bubble or contracted-bore types. There is also a Hottinger hair

hygrometer which can be verified and adjusted at saturation. Most of the stations have the combined wind vane and pressure plate of Wild.

The rain-gauges have a receiving surface of 1–20 sq. $^{m.}$ inclosed by a brass ring, and fixed on a post $1^{m.}$ above the ground. The water is measured in a graduated glass. There are two gauges at each station, with a cover, which can be transferred from one to the other. The gauges are made by Fuess at a cost of 27 marks.

The following are the registering instruments used at the normal stations:

The Casella-Beckley anemograph, modified by Fuess. The revolutions of the Robinson cups are transmitted by a chain into the house, and by means of rollers, draw out a strip of paper, which, each hour, is marked by a hammer actuated by clock-work. The wind direction is obtained from a vane, whose shaft, by a chain, turns a type-arrow, which by the fall of the hammer is imprinted on the strip. The paper unrolled is proportional to the wind's velocity and can be measured by a scale. The cost of this instrument is 800 marks. The barograph generally used is the balance instrument of Fuess, in which the tube is suspended from a counter-weighted scale-arm. Attached near the fulcrum of this is a rod with a pencil, which each ten minutes registers on a sheet of paper, moved downwards by clock-work. The pressure scale is multiplied twice, and the reading is obtained by the use of a glass scale. The cost of this instrument is 600 marks. The thermograph used at one or two stations is that of Hipp. By means of the unequal expansion of steel and brass in a spiral coil, of which one end is fixed, the movement of the free end is transmitted to a pencil, which each ten minutes registers by electro-magnets, operated by clock-work, upon paper moved by the same agency. The sheets from the recording instruments are all tabulated for publication.

The instructions to observers are contained in the work "*Instruktion für den meteor. Dienst der deutschen Seewarte.*" For the reduction of the observations the tables compiled by the *Seewarte* are generally used; for the reduction to sea-level those

published by Dr. C. Jelinek. The observations are constantly checked at the *Seewarte*. Department III has a special employé, whose duty it is to check and collate the observations, and this officer inspects the stations.

As before stated, the regular hours of observations are 8 A. M., 2 and 8 P. M. The maximum and minimum thermometers are read at 8 A. M., and the latter instrument set at 2 P. M. Precipitation is measured at 8 A. M. and 8 P. M.

The observations are entered in monthly forms. That for the 1st and 2nd order stations has the following heads:

(1) Barometer reduced to 0° C. 3 observations daily.
(2) Thermometers. Dry and wet bulb. 3 observations.
Maximum and minimum.
(3) Force of vapor in mm. by psychrometer.
(4) Relative humidity in per cent. by hygrometer.
(5) Wind. Direction and force (0 — 12). 3 observations.
(6) Clouds. Amount (0 — 10), form and direction. 3 observations.
(7) Precipitation in mm. 2 observations.
(8) Depth of snow.
(9) Hydrometeors.
Remarks.

The decades are summed, and sums and means obtained for the month.

The observations at the signal stations are entered in this form:

(1) Aneroid barometer at 8 A. M.
(2) Wind. Direction and force (0 — 12). 3 observations.
(3) Weather by telegraphic scale. 3 observations.
(4) State of sea (0 — 9). 3 observations.
Remarks.

The data thus obtained are published, first in the *Monthly Weather Review*, which contains monthly tables of means, sums and extremes obtained from the observations at the normal stations of the *Seewarte*, and secondly in the *Meteorological Year Book*, which contains the observations according to the international scheme, made in conjunction with the other German in-

stitutions and stations, and includes the observations at four stations of the 1st order and 25 stations of the 2nd order.

Weather Telegraphy.—The *Deutsche Seewarte* in its Division III, acts as the central office for weather telegraphy for the empire, and especially for the system of storm warnings for the German coasts.

The telegraphic reports embrace the regions from west Ireland to Archangel, and from Bodö in arctic Norway, to the southern point of Italy, and consist of 98 morning despatches, of which 28 are domestic and 70 are foreign. A smaller number are received in the afternoon. An evening service was begun in 1882, and serving only for the purpose of storm warnings, is maintained only during the winter months. During this time reports are received from 17 domestic and 11 foreign stations each evening.

The reports are generally sent immediately after the observation in the continental cipher, which was adopted by the International Meteorological Congress of Rome. The despatches consist of five place groups of figures, to which sometimes observations in words are added. Each group is paid for as one word. By placing the figures in groups and in a sequence, the sense of each figure is determined, and errors of transmission diminished. In all data the tens, units and tenths come always in the same place; and if there is no figure for any place, it is filled with a cipher, so that the number of figures in the group is always five. The general key for a continental morning weather despatch, which differs slightly from the English cipher, is:

Yesterday Evening.

Group I			II
BBBWW			*SHTTT*

This Morning.

Group III	IV	V	VI
BBBWW	*SHTTT*	$T'T'T'RR$	*MMmmG*,

in which *BBB* is the barometer read to 0.1 mm. corrected for instrumental error and reduced to sea-level. Hundreds of mm. are omitted and 765.4 mm. is telegraphed 654.

WW is the true direction of the wind to 16 points, the even

numbers only out of 32 being given. Thus $N = 32$, $NNE = 02$, $NE = 04$, etc. For a calm, WW is replaced by 00.

S is the force of the wind, according to the Beaufort scale, in which 1 is very light and 12 a hurricane. If the force exceeds 9, this figure is put in the group, and the strength given in words at the end of the telegram.

H represents weather or precipitation on a scale of 0 to 9, the figures from 5 to 9 inclusive, giving the kind of precipitation. The occurrence of hail, auroræ, etc., is given in words at the end of the despatch.

$TT'T$ is the temperature of the dry bulb thermometer to 0.1° C. Thus 13.4° C. = 134, etc. For temperatures below 0° C. 50 is added to the observed number of degrees, thus —0.3° C. = 503, etc.

$T'T'T'$ in the same way gives the reading of the wet bulb thermometer.

RR gives in mm. the precipitation in the 24 hours, ending at 8 A. M. Inappreciable precipitation is denoted by 99.

MM is the reading of the maximum thermometer in whole degrees. The minus degrees are treated as for the other thermometers.

mm is the reading of the minimum thermometer in the same way.

G represents the state of the sea on a scale of 0 to 9, 0 being smooth and 9 very high. As few German stations can observe the sea, the *Seewarte* stations give the form of cloud here, while the coast stations give the sea disturbance under "Remarks."

The cost of these telegrams is paid by the Government, the German General Telegraph having had in 1882, 50,000 marks allowed it for foreign and domestic telegrams.

The 7 or 8 A. M. reports from the 28 domestic, and most of the 70 foreign stations, together with those of the preceding evening, are generally received at Hamburg before 10 A. M.; the 2 P. M. reports from the 14 domestic and 11 foreign stations generally by 5 P. M., while the evening report from about the same number of stations come in more promptly.

The data thus obtained are entered in five charts each morn-

ing, one showing pressure (reduced to 0° and sea-level), wind, clouds, and kind of precipitation at time of observation; one temperature, state of sea and precipitation in 24 hours, and two the changes of pressure and temperature, respectively, in 12 and 24 hours. From the afternoon reports are charted the changes of pressure and temperature in the preceding 6 hours, and in the evenings one chart is drawn for temperature, state of sea and the precipitation in 24 hours, and two showing the changes of pressure and temperature in the last 12 or 24 hours.

On these maps the direction of the wind is indicated by an arrow, and its strength by the number of feathers (1 for each 2 Beaufort), cloudiness by a circle with shaded quadrants, and the kind of precipitation falling by the international symbols. Isobars and isotherms are drawn, and on the maps showing the changes, the words "risen," "fallen," "colder," "warmer," etc., are written. Upon these maps are based the weather predictions and storm warnings issued.

About noon the tabular reports, a synopsis of the weather conditions, with a statement of the probable change, are telegraphed to the sea-ports and to subscribers, partly in cipher and partly in words. The cipher predictions consist of numbers representing combinations of wind, weather and temperature, Detailed statements are sent to the Central Offices of Saxony. Bavaria, Württemberg and Baden, which issue predictions for their respective countries by means of weather charts thus constructed. All predictions are for the following day, and relate to the cloudiness, precipitation, temperature, and direction and force of wind. The predictions for the interior specify direction only when strong winds are expected, since the wind in other cases is of little importance.

The telegraphic observations and a synopsis of the weather are sent by the Central Office to the newspapers, on condition that they shall be published without alteration. There are newspaper observatories at Frankfort-on-the-Main, Magdeburg and Cologne, which from the reports received, and local observations, issue their own local predictions. [The service of the last two newspaper observatories will be described]. Weather maps,

which relate to the current day generally, are published by three Hamburg and four other newspapers.

After the receipt of the 2 P. M. reports and the study of the changes which have occurred, are issued the general predictions for all Germany, which appear in the daily *Weather Bulletin*, and the special predictions for the northwest coast, which are published in the evening editions of the Hamburg and other newspapers. The 8 P. M. reports are worked up as soon as received.

Until 1886 the system of verification of the predictions employed by the United States Signal Service, was used by the *Seewarte* and by the other Central Offices of Germany. By this system the predictions were considered to have been verified, partly verified, or not verified. Half of the partly verified predictions were reckoned with the good, and half with the bad predictions. The percentage of success for the elements of weather, temperature and wind, for all Germany, was, in 1885, 83. Since 1886, the more scientific method of verification devised by Dr. Köppen has been used by the *Seewarte*.

The lithographed *Weather Bulletin* appears about 5 P. M. daily (except Sunday), and leaves Hamburg by the evening mail. About 175 copies are distributed, and the subscription tion price is 60 marks annually. It is a folio sheet, containing on the inside two weather charts of Europe for 8 A. M., one showing the pressure, wind and clouds, the other the precipitation, temperature and state of sea. The pressure is shown by isobars for each 5 mm., the temperature by isotherms for each 5° C., and the other elements expressed by the symbols of the Vienna Congress, with the addition of a sign for cloudiness. Smaller charts show the pressure, wind, cloud and temperature for 2 and 8 P. M. of the preceding day. There is a synopsis of the prevalent weather conditions and predictions for northwest, east, and south Germany for the next day. On the outside pages, in tabular form, are the morning observations of barometer, thermometers, humidity, wind, weather and clouds, the precipitation and the maximum and minimum temperatures in 24 hours, and the observations of the preceding evening of barometer, wind

and weather. Reports of most of these elements for some of the German and a few foreign stations for 2 P. M. of the current day, and tracings of the registering instrumenst at Hamburg up to 8 A. M., complete the data furnished by the *Bulletin.*

For the purpose of storm warnings the signal stations are divided into two classes. Those of the 1st class are provided with a signal mast, on which are displayed a cylinder and a cone to indicate the quarter and force of the wind, and red flags to show its change of direction. The meaning of these signals is as follows: A cone, point upwards, indicates a moderate storm from the N. W.; a cylinder with the cone above it, a severe storm from the same direction. The same arrangement with the cone point downwards, indicates similar winds from the S. W. or S. E. One flag indicates a probable veering of the wind, and two flags backing. The 2nd class stations display only a ball (replaced at night at same stations by a red lantern), to call attention to a probable storm concerning which information can be had from the telegram which is posted at the office. The warnings are intended to apply within an area of 100 square miles of the place where this signal is displayed. A record of the signals and of the succeeding weather is kept at the signal stations. The manner of verifying the storm warnings is the same as for the weather predictions, the signal being considered as verified, partly verified, or not verified. Late warnings are either not counted or considered as partly verified. The verifications of nine years' storm warnings show that 55 per cent. were followed by gales of 8 Beaufort or over. The percentage of success in 1885 was likewise 55 per cent. The verification of both storm warnings and weather predictions is published in the *Monthly Weather Review.*

Maritime Meteorology.—The organization of maritime meteorological observations has been carried out since 1876, according to the decisions of the London International Meteorological Congress of 1874. Verified instruments are supplied by the *Seewarte* and chief agencies at Bremerhafen, Swinemünde and Neufahrwasser, and fourteen other agencies have been established along the coast to awaken interest in meteorological work,

for the examination of registers and for the testing of instruments, and to spread the benefits which navigation may derive from these investigations. In 1882 three hundred and forty-three complete meteorological registers were received by Division I of the *Seewarte*, representing observations made six times a day at the hours agreed upon by the International Conference. These observations comprise time, latitude and longitude, course and distance traversed, deviation of compass, wind direction and force, barometer and attached thermometer, wet and dry bulb thermometers, form of clouds and appearance of sky, weather, height and direction of waves, temperature and specific gravity of water, etc. These data, which are spread over all the commercial routes of the ocean, are of the first quality. Ordinary logs containing observations made, not with the instruments of the *Seewarte*, but with instruments tested at the *Seewarte*, are excluded from the collection and discussion.

The material collected is used in three different ways:

1. Extracts are made of meteorological observations, and matters interesting to navigation are extracted from the ships' logs, and are at once published in the *Annalen der Hydrographie u. maritimen Meteorologie.* Such data as relate to the track of storms, ice., etc., are published in the *Monthly Weather Review.*

2. The results of the observations, combined with those made on board Dutch ships, are arranged in climatological and general meteorological tables, and published in one degree squares for each month.

3. The *Deutsche Seewarte* constructs synoptic charts for the North Atlantic Ocean, and for each day of the year. The Danish Meteorological Institute and the *Deutsche Seewarte*, by means of this material and that obtained from the Danish ships, have issued daily synoptic charts since December, 1880.

All the observations obtained from seamen are made without pay. They receive in return the publications of the *Seewarte*, together with medals and diplomas. The expenses of the Department, exclusive of publications, were, in 1877, 40,000 marks.

In Division II, meteorological, nautical and magnetic instru-

ments are tested, and the models and instruments of the Central Office cared for. Researches have been conducted upon iron ships with respect to the deviation of their compasses, and in 1885 one hundred deviations journals were received and discussed. The values of the magnetic elements at various ports have been determined.

In Division IV, chronometers are tested by the Astronomical Observatory, for the compensation required for motion and temperature. This test lasts at least four months. In order to enable seamen to regulate their chronometers, time-balls have been erected by the astronomical observatories in Hamburg, Kiel, Wilhelmshafen, etc.

[TO BE CONTINUED]

A CLASSIFICATION OF THE WINDS.

By William Morris Davis.

The assistance that classification lends to study of all kinds may serve as reason for presenting a paper whose only claim to novelty is in the arrangement of its material. Its object is to classify the movements of the atmosphere according to their physical causes and conditions, for the convenience of observers and teachers. The characteristics that are employed in distinguishing winds of different kinds are: 1st, source of energy that excites motion; 2d, (except in two cases) arrangement of contrasted temperatures; 3d, period of occurrence; 4th, in some subordinate cases, relation to or dependence on a larger disturbance. The general scheme is as follows:

Source of Energy.	Contrasted Temperatures.	Period.	Kind of Wind.
Earth.	Internal and External.	.....	Volcanic Winds.
	.....	.....	Land-Slide Winds.
Moon.	.....	Lunar Day.	Tidal Winds.
Sun.	Equator and Poles.	Annual.	Planetary. Jovian. Terrestrial.
	Land and Sea.	Annual.	Continental. Uranian.
		Diurnal.	Land and Sea Breezes—Littoral.
	Mountain and Valley.	Diurnal.	Mountain and Valley Breezes.
	Vertical.	Diurnal (summer).	Desert Whirlwinds.
		Nocturnal (winter).	Bora.
	Lateral.	Irregular (tropical).	Cyclonic Winds.

The sub-divisions of the cyclonic winds and a few uncertain cases will be given below.

The reason for placing the winds that owe their origin to the earth alone, or to the moon's action on the earth, before the winds of solar origin, is simply to emphasize the trivial character of the former. Volcanic storms may be violent, but they are rare, local and short-lived: they are interesting, however, in representing on the earth the last stages of a class of winds that seem to be still in full development on the sun. Land-slide winds are as destructive as they are exceptional; they are winds that are brushed forward by a land-slide, so as to advance much beyond the limits of the slide with sufficient violence to overturn trees and houses. Such winds are well known in Switzerland. Tidal winds have been suspected by Laflamme in the Gulf of St. Lawrence, where the water has a strong ebb and flow; they are thought to result simply from the displacement of the air by the oscillating water, not from any direct attraction of the moon. An automatic wind-register at the head of the Bay of Fundy, from which direction and velocity might be learned on anti-cyclonic days in the autumn, when the gradients and land-and-water contrasts of temperature are small, would soon give data for their detection. Lunar winds of other kinds, if they are perceptible at all, are too delicate to need attention here. All other winds have their source in solar energy.

All planets possessing an atmosphere, whose temperature depends chiefly on radiation from the governing sun, will be characterized by planetary winds. The simplest of these would appear on a planet whose axis stands at right angles to the plane of its orbit, and might therefore be called the Jovian; the most complicated would be found on a planet that alternately presented one and the other pole to the direct solar rays, and might therefore be called the Uranian. The intermediate type of planetary winds that we enjoy on the earth may be called Terrestrial winds, as they belong to the earth as a whole. If unmodified by geographic irregularities, they would consist of the trade-winds and the westerlies below, and the oblique overflowing anti-trades above, with calms around the equator, at the horse-

latitudes and at the poles: following the sun, the calm zones migrate north and south, and the winter hemisphere has the highest velocities.

Continental winds characterize large land surfaces: they depend on the unequal annual changes of temperature on land and water, and flow towards the warmer surface; towards the land in summer, towards the sea in winter. It is not easy to find unmodified examples of continental winds; but in conjunction with the terrestrial, on which they are superposed, we see them in our southwesterly winds of summer, and northwesterlies of winter; or in the summer northwest wind of Europe, and the winter southwest. On the eastern coast of Asia, the continental indraft of summer reverses the westerly wind of the planetary system into the southeast monsoon. India presents an example of excessive migration of the equatorial calm belt of the planetary system far north to the Indo-Gangetic plain, where continental temperatures draw it; the southeast trade then appears as the summer or southwest monsoon. The southwest monsoon of the equatorial Atlantic is essentially terrestrial, not continental in origin.

The local combination of planetary and continental winds may be called the general or prevailing wind of a place.

These long-period winds have a distinct diurnal variation in velocity, as explained by Espy and Köppen, and a fainter diurnal variation in direction, as shown by Sprung. At the surface of the earth they blow faster and turn to the right (to the left in the southern hemisphere) by day, slower and to the left by night; above a certain distance over the surface, at present undefined, they act in the opposite way.

Continental winds, on a planet with as long a year as ours, may stretch all across a continent. But contrasts of temperature between land and sea during day or night are so short-lived that the winds thus excited extend but little distance from the shore-line, as in the land and sea-breezes. These appear best in the faint gradients and steady weather of the tropics, or on anti-cyclonic spring and summer days with us. They seem to be well marked on small islands, but this is probably because

such islands have weak winds of other kinds. They might be called littoral in contrast with the preceding class.

The planetary, continental and littoral winds would appear on a level earth. Winds of another character are found in mountainous countries, where the air is warmed and cooled most at its contact with the ground, and hence is warmed and cooled more on the lateral slopes than at the same altitude in the open space over the middle of the valley. There is consequently an up-cast or valley-breeze by day, and a down-cast or mountain breeze by night. The latter is most distinct at the mouth of its valley; the former is stronger some distance up stream.

Under certain circumstances, the air becomes unstable from being too warm below or too cold aloft. The simplest case of the kind is seen in the dust-whirlwinds on deserts, when the lower air on warm, calm days is so far expanded as to be even specifically lighter than the air above it. The want of geometrical perfection in natural arrangements generally disturbs the unstable equilibrium thus produced, and a rising, whirling column of dust marks the place of upsetting. These whirls are as characteristic of hot deserts as sea-breezes are of tropical shores. The diurnal variation in velocity of long-period winds, above referred to, arises from instability of this kind but of less intensity.

Cooling the upper air produces instability as well as warming the surface air; but the upper air alone changes its temperature too little to cause any tendency to top-heaviness. Yet on a plateau, where the air is thin, dry, and pure, conduction of heat from the air to the quickly cooling ground may, during night or winter, be so rapid that the air will fall to a much lower temperature there than in the adjacent valleys. It is then top-heavy, and if opportunity offer, it will run over the edge of the plateau and down to the lower ground with much violence. If the upper cooling be excessive, the descending wind will be colder than the air that it displaces in the valley bottom, in spite of some warming by compression during descent. Examples have been described in which such an overflow, aided by cyclonic gradients, caused a disastrous aërial cataract, known as the *Bora*.

Our general cyclonic storms are as yet still in need of much study, but it is perhaps safe to say that they are essentially the flow and counter-flow between large masses of air, laterally adjacent and of unlike temperature and humidity, the air at the center of the cyclone being unduly warm and moist compared to that around it. In tropical cyclones, this arrangement is pretty well demonstrated; but in cyclones of temperate latitudes, especially in winter when they are stronger, they are so unsymmetrical in the distribution of temperatures that they almost fall out of the cyclonic class. The complete and symmetrical cyclone consists of several parts; a central calm, a strong oblique cyclonic inflow around the center, a peri-cyclonic calm and faint, exterior, oblique outflow; these are all best developed at the surface and disappear or are reversed above. Ordinary anti-cyclones probably result from the overlapping of two peri-cyclones. The points of resemblance and difference between these relatively small, warm-center cyclones and the great cold-center circulation of planetary winds around either pole have been fully worked out by Ferrel.

One of the most marked characteristics of cyclones is their progression from place to place; in this they differ from all winds yet mentioned, except the little dust-whirls. They are also irregular in period, except for the general association of tropical cyclones with the equinoxial season, and of our stronger cyclonic storms with winter. Having a duration of several or many days, their winds show something of the diurnal variation in velocity, but their most marked changes in both velocity and direction of wind as noted at a single station result from the successive presentation of their different parts to the observer. The peculiarities of their several parts are determined less by absolute direction and velocity than by their geographic path, in accordance with which they may be classified. The member of the cyclonic circulation that is most familiar to us is the "cold-wave"; it has a more perfect development in the central and eastern United States than anywhere else. It is here a northwest wind, reinforced by the winter condition of the combined terrestrial and continental circulation; it is a very

strong, cold, dry wind, carrying abnormally low temperatures even down to the Gulf of Mexico. The blizzard is a cold-wave with snow squalls and drifting snow. The Norther of Texas is only a local name for a wind of the cold-wave type. In summer time, this wind is only a "cool-wave." On the eastern coast of Asia, the winter cold-wave is well developed, but attains less strength than with us on account of the mountains between its source and its goal. On the Mediterranean coast of France, this wind is called the Mistral. In western Europe, the cold-wave is a northeasterly instead of a northwesterly wind; here we see the need of naming these cyclonic winds by their physical characteristics rather than by their direction.

The Sirocco of Italy is also a cyclonic wind; sometimes hot, dry and parching, sometimes warm, moist and sultry. The name may well be introduced with us. In winter, we often have a moist Sirocco on the forward side of a cyclone; an excellent example occurred in New England in December, 1886, when the absolute maximum of the month was reached close to midnight of Christmas eve, with southerly wind and heavy rain. Our dry Siroccos in New England are characteristic of spring and summer, when southwest winds come to us from the warm southern states.

The Fœhn is as well-marked as either of the preceding types. When a cyclonic indraft is drawn down from or over a mountain range, it becomes warm and dry in the lower valleys. It is well known in Switzerland, in the Rocky Mountains, and elsewhere; it was perceived in faint development in the White Mountain valleys a few times last winter. The Bora also deserves mention here, as it seems to need cyclonic aid in gaining its first motion.

As a consequence of the strong contrasts of temperature induced by the cyclonic circulation, local storms of great intensity and small area are often developed. They are offspring of cyclones. The thunder-squall is among the most common and best marked of these; it seems to be formed along the contact, either lateral or vertical, of the warm and cool, moist and dry winds on the equatorial side of the cyclonic center; it has a

heavy cumulus cloud-mass, a far over-reaching cirrus top, and a rolling squall-cloud at its lower front edge, from below which a violent straight-line squall rushes out ahead of the rain. Being of destructive strength, and of moderate duration—five to thirty minutes—it has probably been sometimes confused with the tornado. The arched-squall of the torrid zone is probably of more spontaneous development, with less cyclonic aid, but its nature is not well understood. When poorly developed, a thunder-squall would be called a thunder-storm or a thunder-shower, and thus confused with all storms from which thunder may be heard. In warm mountain regions, the valley-breeze may normally build up a thunder-shower in the afternoon. On mountainous tropical islands, the sea-breeze co-operates effectively with the valley-breeze to the same end. Tropical cyclones produce violent lightning, but are not thunder-storms or thunder-squalls at all in the sense above defined. The daily thunder-storms of the Doldrums, of the Brazilian coast and other torrid regions seem to be of local development, probably associated with diurnal changes of temperature, such as cause winds already classified; the heavy storm at the bursting of the monsoon in India seems to belong under the monsoon winds; it is therefore doubtful whether these storms deserve a place by themselves; they may be simply the climax of some simple process already included in the list.

The Tornado, distinguished by the funnel-cloud from all other local storms, is probably in most cases the offspring of cyclonic winds; indeed, it is so closely associated with violent thunder-storms that it seems in many cases to be only a special, local development within them, occupying but a small part of their total area. It is desirable that more attention should be given to the relation between the funnel-cloud and the large cloud-mass from which it hangs. Water-spouts are generally to be regarded as tornadoes at sea; but little is yet known of their relation to the surrounding winds.

Apart from the value that systematic arrangement of facts and theories has for the student, it may be of great service to the explorer. It is at present generally difficult to gain much

information about winds from books of travel, because the records are indiscriminate: it does not seem to be sufficiently understood that winds of certain kinds may be expected in certain places; hence omissions of record and difficulty of discussion. For example, an explorer in a mountain region, encamped at evening in a valley, should then and there notice whether the breeze that is felt flows down the valley or not; its relative intensity on cloudy and clear nights in the same valley, and on similar nights in different valleys, should be estimated. A wind springing up by day in an open country and dying away at night may be taken as a good indication of the general wind of the place. A wind beginning by night in an open country, or blowing up-stream by night is likely to be a cyclonic wind; a wind in an open country, blowing almost steadily but veering or backing more than three points in twenty-four hours, is probably a cyclonic wind; so is a wind that brings steady rain in an open country, and these winds are probably not the prevailing or general winds of the place. Observations on sea or lake coasts should be taken with especial reference to the diurnal oscillation of the littoral winds: when these are absent in the summer season and clear weather, the wind that occurs is probably a cyclonic increase or reversal of the general winds of the place. It is therefore not enough that an explorer take the ordinary mechanical care of his wind records; observations ought always to be recorded with due regard to his geographic surroundings. Geographic meteorology would then prosper.

There is another advantage in classification that comes from its likeness to "taking stock." It brings what is known together in convenient shape, and leaves the unknown, unsorted material to one side, thereby calling especial attention to its need of critical examination.

Thus the simoom (samum), harmattan and many other local winds, omitted from the list given above, are omitted intentionally, because they cannot now be satisfactorily classified. How are they caused; with what other winds are they associated? They need intentional, well-directed investigation, just as unknown lands need exploration. Fine study is needed on the little breezes that interrupt our ordinary winds; and when it comes to the currents aloft, as manifested by the clouds, there is a large field open in which much that is new may be found.

THE PONTOTOC METEOR.

By Col. R. Bolton.

"There are more things in heaven and earth, Horatio,
Than are dreamed of in your philosophy."—Hamlet.

The appearance of a shooting star, a mere streak of light, gliding along at the verge of the atmosphere, at the height of fifty or sixty miles, and quietly going out, is so common as to excite little attention. A bright, luminous ball, or a star wrapped in fire suddenly appearing, and rushing through the air as if to destruction, mystery and force combined, is calculated to awaken deeper emotions, especially if, when falling toward the earth, it emits vivid scintillations or explodes with the sound of thunder and casts masses of heated rock with violence to the ground.

Such masses weighing from a few ounces to more than fifteen hundred pounds have been collected, analyzed by the chemist, and found to be composed of silex, magnesia, sulphur, metallic iron, nickel and some chrome; the last two are not very common at the surface of the earth.

They are supposed to be of cosmic origin, perhaps small stars wandering in space, or revolving around the sun, into which many appear to fall and be consumed; while others penetrating the earth's atmosphere, are intensely heated by the friction of its resistance, and cast off luminous particles or fragments and fall to the earth, or pass away into outer space.

In the summer of 1860 I was at Newport, intending to state the following facts at the meeting of the A. A. A. S. then in session, of which I had been a member. But being suddenly called home by sickness in my family, the civil war and cares following caused further delay, while giving ample time for studies of the phenomena, which are now for the first time given to the public.

On July 8, 1856, the most brilliant meteor known in this region, was seen from Memphis and Jackson, Tenn., to Corinth, Columbus and Grenada, Miss., and described in the newspapers of those and the intermediate towns.

I could not learn over what point it made its first appearance.

My informant at Holly Springs saw it due east at the elevation of about 50°. Thence in its course of forty-two miles east of south, it continued to emit vivid scintillations, like a rocket shooting obliquely downward to a point about six miles from Pontotoc, Miss., when an explosion was seen, which, as described by hunters under it, "lighted the dense wood around them with a light brighter than the sun." This was followed by two other explosions at intervals of perhaps two or three miles, when it disappeared. These explosions were followed soon after by a succession of forty or more detonations, variously described as thunder, the firing by file of infantry, or the rattling of a wagon-load of empty boxes driven rapidly across a rough bridge.

At the time, I was in my office, when the appearance of lightning followed by thunder caused my hasty departure. On arriving at the court house square, I saw every eye turned upward, and was informed by a bystander that "there had been the most singular thunder and lightning he had ever known, and it had made a cloud," to which he pointed.

The air was perfectly calm, the sky blue and clear, except two small cumuli several miles to the west. In the S. S. W. below the moon, then near its first quarter, appeared a spherical cloud, in violent commotion, enlarging itself. I have seen on a calm afternoon the same appearance in the puffs of steam escaping at every movement of the engine from the pipe of a large steamboat, moving very slowly up the Ohio river. South of this cloud, and extending downward at an angle of about 45°, appeared two similar clouds, of sizes diminishing as they were farther from me.

I did not see the clouds unite, but in about half an hour a single cloud occupied the place of the three, appearing wider at the upper end, and having somewhat the shape of an elongated egg.

Near sunset the cloud had lost its rounded form, and taken that of a layer with hemispherical protuberances on its lower surface, which appeared in color and in lustre to be composed of clusters of small pearls, not larger than the heads of ordinary dress pins.

After supper, I think before eight o'clock, I went out to view the cloud, and found it greatly changed. It appeared to have less density, and its matter to be irregularly distributed. In the right or wider part, appeared a few white lines forming imperfect angles. In the lower end, at what I suppose the place of the third explosion, I saw distinctly drawn in white lines against the gray sky the letter N inclosed in M, as shown in figure 2 of the cut, and photographed on my memory. My family was called out and saw it, and as I went out several times afterward, it must have remained visible for at least twenty minutes—I think much longer.

A possible explanation of some of these phenomena may be as follows: At each explosion the flame seemed not only to move forward, but in the words of my informant "to jerk backward" as if to fill a vacuum behind it. The great heat generated would be radiated outward and cause the cylinder of air thus heated to absorb an additional quantity of moisture from the external atmosphere. As the air of the cylinder became cooled by radiation to the normal temperature of that high region, the surplus of moisture would be parted with in the form of particles of snow, and mingled with the meteor dust, become visible as a cloud. This having weight would fall until balanced by a stratum of air of greater density; and would assume the form, usual at that height, of cirro-cumuli, appearing very small in the distance (estimated at about eleven miles) and lustrous, illuminated by the setting sun.

The letters M and N were, I suppose, formed on the principle of sound figures, which is thus explained by Mary Somerville.

"If a little fine dry sand be strewed over the surface of a plate of glass, and if undulations be excited by drawing the bow of a violin across its edge, it will emit a musical sound, and the sand will immediately arrange itself in the nodal lines, where alone it will accumulate and remain at rest. The lines in circular plates are remarkable for their symmetry, and consist of diameters dividing the circumference of the plates into equal parts."

The particles of meteor dust and frozen snow, lying upon a stratum of elastic air, would, like the glass and sand, be liable to

vibration, and to collect in nodes, and the undulations could be excited by a current of air (even at a distance below), perhaps the usual western wind.

Among the various sound figures represented by Chladni, the edges of the square plate seem materially to influence the shape of the figure. But the circular plate on which he shows the figure formed on three diameters, at equal angles of sixty degrees, and of lines of equal length, appears to suit better the conditions of the meteor figures.

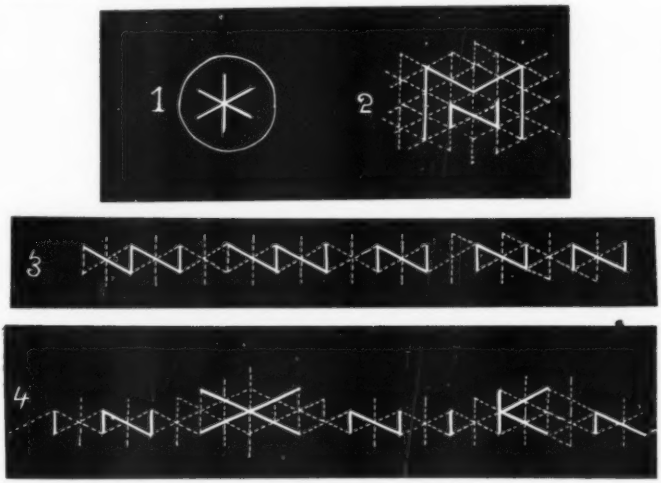


FIGURE 1.—The sound figure of Chladni on a circular plate.
FIGURE 2.—The letters seen at Pontotoc, and their supposed formation.
FIGURE 3.—The supposed form and formation of the Salt Lake letters.
FIGURE 4.—The supposed form and manner of formation of the "celestial sign" of Constantine.
The dotted lines represent the supposed nodes of vibration at which no cloud-matter was collected, or collected in such small quantities as to be invisible at a distance.
The black lines, which, as seen, were white against a blue or gray sky, represent the nodes, on which the cloud-matter was visible.

Now connect the points and place together a number of these star figures, keeping one line of each vertical, and a figure is formed consisting of equilateral triangles, the lines of which represent the nodes in which the dust or snow might collect, and it is readily seen how the letters M and N, seen by me, may have been formed as shown in Figure 2 of the cut.

As nearly as I could estimate, the width of the N appeared one-third and of the M two-thirds of the diameter of the moon; and the height of the letters above the earth four or five miles, and its distance in a direct line eleven or twelve miles.

An idea may be formed of the appearance of the letter N by looking at a pane of glass ten inches wide, in an uncurtained window from the distance of about one hundred yards. The glass represents the background of sky, and the white putty and wood on each side the vertical lines of the letter.

A confirmation of this hypothesis may be found in the report of the chief signal officer for 1880, on page 621.

An observer thus writes:

"Salt Lake City, Sept. 5, 7:10 P. M.; brilliant meteor appeared a few degrees south of west, and shot across the sky in a northwesterly direction, leaving behind it a bright silvery streak 7° in length, and resembling a cloud. One striking peculiarity of this streak was a resemblance to certain letters of the alphabet, two W's being plainly visible and followed by a succession of N's. It disappeared at 7:25 P. M., having at that time a pinkish color, the sky during the whole time being perfectly clear. (See Figure 3 on cut.)

The great value of the Pontotoc meteor is found in its affording the means of penetrating the obscurity of centuries and verifying and explaining one of the most celebrated occurrences of history, the "celestial sign" of Constantine.

In October, A. D. 312, the army of Constantine was marching southward by the Flaminian road, to dethrone the tyrant Maxentius, then awaiting battle at the Milvian bridge. At noon, on the day before the battle, when near the Saxa Rubra, nine miles from Rome, Constantine and his army "saw above the meridian sun the luminous trophy of the cross" inscribed with these words, "by this conquer."

Substitute for the Latin words in which this is usually quoted, "In hoc signo vinces," the corresponding Greek expression, *IN N NIK A*, and the celestial sign is found to be composed of letters like those of the Pontotoc Meteor, and like them may be formed on a diagram of equilateral triangles. (Cut, Fig. 4.)

As evidence that this was the original form of the letters, the celebrated standard of Constantine is engraved on some of his medals with the famous inscription, *EN TOYTΩI NIKA.*

And in the reign of Justinian, about the year A. D. 530, during five days Constantinople was abandoned to the factions whose watch word *NIKA* (vanquish) has given a name to this memorable sedition.

These letters, seen nearly overhead, and at less than half the distance of the Pontotoc letters, would have appeared more than twice as large, and the *N*, corresponding in greater size to the Pontotoc *M*, would have had nearly twice the magnitude of the sun, and illuminated by its light must have been exceedingly impressive.

The effect of the celestial sign upon the army was immediate and powerful.

In such an age of superstition it was natural that the celestial sign should be regarded as a proof of the truth of Christianity, and a pledge of divine protection, and should confound the disbeliever and inspire the Christian with the highest enthusiasm for the coming conflict, and cause many to inscribe the *N* upon their shields and helmets as "an infallible preservative against every species of spiritual and temporal evil."

At this time Paganism and Christianity were nearly at an equipoise in the minds of men. The adherents to the former, the religion of the state, were influenced by habit rather than conviction, while Christians were full of enthusiasm for a religion which satisfied their faith and for which they had sufficient persecution. It was evident that a contest was impending in which one of the two religions must be overthrown.

The emperors at Rome and Constantinople sustained the Pagan system. Constantine, whether from conviction or policy, had favored and protected Christians in his part of the empire. Evidences of personal enmity on the part of the emperors towards him may have first suggested to his ambition a bold stroke for empire, and the sagacity of a statesman advised the recognition of Christianity as a means to that end.

It was also natural that in the disturbed sleep of Constantine

in the night preceding the decisive struggle, the sights and thoughts of the day should be reproduced in a dream, and that he should appear to receive the divine command to adopt the cross for his standard, and to have it engraved on the defensive armor of his soldiers, as a defense.

The new "standard which displayed the triumph of the cross, a long pike having for its head a crown of gold inclosing the letter ☧, the initial letter of the name of Christ and figure of the cross, was called Labarum or Laborum, an obscure but celebrated name which has vainly been attempted to be derived from almost all the languages of the world." Perhaps the circumstances of its adoption by the army may suggest the origin of the name.

The "Roman soldiers at the time of their enlistment took an oath, renewed by each, annually thereafter, to obey the commands of their officers, and never desert their Standard. The golden eagle which glittered in front of the legion was the object of their fondest devotion, and with the other deities received the religious worship of the troops."

The golden eagle was regarded by Jews and Christians with abhorrence as an idolatrous image, "the abomination of desolation spoken of by Daniel the prophet." The adoption of the cross in place of the eagle would therefore be the rejection of Paganism and acknowledgement of Christianity.

We may suppose the ceremony of presentation to the army to have been this: The minds of the soldiers having been prepared, and the legion drawn up in compact order, an officer of high rank would present the standard in the Greek words, "Labete ruma," (Labete, receive it; ruma, as your defense.) The response would be heard in the united shout, Labo-room (Labo, I receive it; ruma, as my defense; meaning in place of the idolatrous eagle). This shout, reminding them of their adoption of the standard, and of the ☧ on it, the monogram of the name of Christ the Saviour, and symbol of the cross on which he suffered, might readily become the name of the celebrated standard.

This was the first public recognition of Christianity as the the religion of the Western Roman Empire, and such it has con-

tinued to be except during a short interval under Julian. In the Eastern Empire and Africa the cross was supplanted by the crescent—but the crescent is waning to extinction, and the idols of Paganism are beginning to totter on their pedestals—while the Christian nations are the most civilized, enlightened and powerful on earth.

The kingdom of heaven, the power of the Christian religion over the hearts and consciences of men, is slowly but surely advancing through the world.

The story of the celestial sign is thought by Gibbon, from whom I have quoted freely, to be contrary to human experience and therefore a Christian fable, confirmed by perjury of the emperor. If it was a miracle, as Eusebius believed, it was like the miracles known as the plagues of Egypt, the effect of natural causes, supernaturally brought into action at an important juncture for a divine purpose.

PRESSURE AND TEMPERATURE IN LOW AND HIGH AREAS.

By H. Allen Hazen.

It will probably be admitted that there are few questions in the science of meteorology of greater importance than the fluctuations of pressure and temperature, from the sea level to great heights, in the centre of our storms and their opposites. Till quite recently, little has existed in this field aside from vague speculations and statements of unsatisfactory theories. It is quite surprising that, in the most recent discussions of this question, results almost directly contradictory, have been obtained by different investigators. Such results show how useless it is for us to theorize about the movements of great masses of air, brought about by changes in their temperature and pressure.

The more recent discussion was started by M. Dechevrens, of Zikawei, a translation of whose article was published in this Journal for August, 1886. Later on he published another article on this question, and his views were accepted by Dr. Hann, of Vienna. A discussion of the same question was car-

ried on by the present writer, entirely independently of M. Dechevrens, and the results arrived at were in many respects opposed to his. In the January number of the *Meteorologische Zeitschrift*, Dr. Hann has a lengthy article which it may be interesting to review, especially as the results seem to be not in accordance with American observations. I am well aware of Dr. Hann's position in meteorology, and it is with great diffidence that I take issue with him on this question. His methods of working seem to me so objectionable and the interests involved are of so great importance, that I may be pardoned for giving my view of his investigation.

Some points should be carefully born in mind: 1st. The question under discussion is this, What are the conditions of temperature and pressure at a considerable height above the earth, during the passage of storms and high areas?

2d. What are the causes acting in producing these conditions?

3d. Is it possible to obtain a knowledge of these conditions by observations upon high mountains?

4th. We must carefully distinguish effects brought about by the passage of low and high areas from all other sources of disturbance.

The theory usually held is, that when a storm passes, the temperature at the earth's surface rises and this rise extends up to a great height; on the other hand, the pressure falls markedly at the earth's surface, but owing to the rise in temperature, this fall in the lower air strata is partially counterbalanced, and finally, a stratum will be reached where the pressure remains stationary. This is called the "neutral plane," and theory indicates that above this the pressure must rise. M. Dechevrens determined the temperatures corresponding to the pressures at high stations and found that usually low temperatures occurred with low pressures and *vice versa*. In this he was followed by Dr. Hann. It seems to me that it is of the utmost importance in this discussion that we do not take promiscuously all pressures that are observed, but examine only those which occur where the low or high area is passing. Almost the lowest pressure ever observed on Pic du Midi, occurred during the

passage of a high area at its base, and the temperature at the summit was exceedingly low. Dr. Hann says, that storms rarely cross the Alps, and if this be so, then it is very evident that this question cannot be discussed by observations in the Alps.

Dr. Hann's principal point in the article above referred to is made as follows: He first takes the pressure at the base of some of the higher mountain stations, from the synoptic charts, and compares that with the pressure at the high stations, also obtaining the temperature at the same time. His results for Sonnblick are given in the following table:

Pressure.		Temperature.		Pressure.		Temperature S'k.	
Sea.	S'k.	7 a. m.	Mean.	Sea.	S'k.	7 a. m.	Mean.
751	508	—13.2	—13.1	753	514	—5.9	—5.7
759	514	—13.5	—13.2	759	523	0.0	0.5
764	514	—17.4	—16.6	764	526	—0.4	0.4
769	519	—15.1	—14.6	767	527	—2.5	—1.3
775	525	—12.3	—11.8				
Dec., Jan. and Feb.				June, July, Aug. and Sept.			

These results are precisely what was to be expected from such a discussion. In both winter and summer they contradict the previously published results of M. Dechevrens and even of Dr. Hann himself. Instead of showing the lowest temperature with the lowest pressure, and a gradual increase with the higher pressure, they practically show no effect at all corresponding with the change in pressure. The bearing of these figures on the problem is not very evident. The results at Säntis, another high station, show even less change than that at Sonnblick.

I will touch upon only one or two other points in Dr. Hann's paper. On page 8 I find, "The phenomenon that the higher strata in the midst of a winter high area, which, according to observations in the Alps, appear to be in the region between 1400^m and 2400^m, show an abnormal heat, while at the same time valleys and low places show negative temperature departures, must at present be looked upon as one of the most firmly established facts in meteorology. Mr. Hazen's doubt about this can

not be considered in the face of the abundant and regular observations during high pressure in the Alps, and especially in middle Europe." While it is difficult to understand why observations in Europe should not give a law applicable to other countries, yet one thing is very certain, and that is that nothing equal to this is observed near Mt. Washington. I have gone over very carefully the records for December, January, February and March for Burlington and Mt. Washington for the period December, 1873, to March, 1883,—40 months. In this interval I have found 21 instances of a noticeable inversion of the temperature. It will be seen that this indicates a very small percentage of the 160 high areas that passed the summit. Another consideration, however, is of still greater importance. The passage of a large number of these high areas produced a very marked effect upon the temperature, lowering it 6° C. as compared with the value 24 hours before.

Dr. Hann also cites Kämtz as having shown that during the passage of a storm the difference between the temperature at the base and summit of a mountain is much increased. As I just stated, it would seem that observations in the Alps should be fairly applicable to other countries, but certainly this statement is not in the least borne out by the records at Mt. Washington, where the difference in temperature between base and summit is least at the moment of passage of the storm centre. I see no reason to change any of the views already expressed in the October (1887) number of this JOURNAL.

February 23, 1888.

CURRENT NOTES.

AIR TEMPERATURES.—Mr. H. S. Eaton read a paper before the Royal Meteorological Society December 21st, 1887, on the mean temperature of the air at Greenwich, in which the follow-results were announced:

1. That there was no appreciable change in the mean temperature of Greenwich from 1812 to 1855, inclusive.

2. On the eminence on which the Royal Observatory is situ-

ated the average temperature at night, or rather the early morning, is in all cases higher than over the lower ground.

3. That with a north wall or, possibly, a north window exposure, higher maximum temperatures are found at the lower stations.

4. That the movements of the thermometer are retarded with a north wall exposure, as compared with an instrument on an open stand, especially where the situation is a confined one. The indications of the thermometer not following changes of temperature so promptly, owing to the modifying influence of the adjacent building. A. L. M.

AIR-PRESSURE AND THE MOON.—Mr. A. Poincaré gives* the following table of the mean barometer readings at the parallels of 40° and 10° north latitude on the days of the lunistices from April 26th to November 30th, 1883.

AUSTRAL LUNISTICES.

	April 26th.	May 23rd.	June 19th	July 16th	Aug. 13th	Sept. 9th.	Oct. 7th.	Nov. 3rd.	Nov. 30th.	Mean.
40°	29 914	29.892	29.853	29.892	29.955	29.961	30.106	30.210	30.192	29.998
10°	.910	.906	.928	.928	.910	.903	29.956	29.931	29.939	.924
Diff.	+0.004	−.014	−.075	−.036	+.045	+.058	+.150	+.279	+.253	+.074

BOREAL LUNISTICES.

	May 9th.	June 5th.	July 3rd.	July 30th.	Aug. 26th.	Sept. 22nd.	Oct. 19th.	Nov. 16th.	Mean.
40°	29.942	29.981	29.959	29.906	30.006	29.999	30.220	30.260	30.034
10°	.844	.842	.828	.834	29.839	.853	29.889	29.822	29.844
Diff.	+0.098	.139	.131	.072	.167	.146	.331	.438	.190

EQUINOXES.

Difference of the Differences.

+.094	+.112	.153	.214	.206	.167	.108	.027	.122	.109	.088	−.004	.181	.052	.159	.185

The parallels of 40° and 10° never coincide exactly with those of the mean maximum and minimum pressure. Besides, there generally exists an intermediate parallel giving an absolute or secondary maximum or minimum. Nevertheless, the mean gradients of 40° and 10° are of contrary sign at the austral and boreal lunistices in May, June and July. In the other months

* *Comptes Rendus*, T. CV., p. 1195, December 12, 1887.

considered here, they are, except at the moment of the equinoxes, much lower in the austral than in the boreal lunistice. For the eight months the mean relation between the two respective gradients is two-fifths.

The above conclusions are drawn from the calculations of the mean barometers for every day of the year 1883. A. L. M.

THE LOGS OF THE GREAT RAFT.—Although nearly two and one-half months have passed since the great raft was abandoned south of Nantucket, reports continue to be received from vessels falling in with the logs, which are now widely separated. The general drift has been in an E. S. E. direction, the logs being found a little to the southward of this line. That they were not carried more to the northward and eastward by the Gulf stream, as would be expected, was probably due to the strong N. W. winds which prevailed during the latter part of December and the first part of January. Fortunately no vessel has been disabled by collision with them, although the German bark "Bremen," which was in company with the logs for five days, in latitude 39° 00′ N., longitude 62° 00′ W., had her sheathing torn and rudder injured. The latest reports of the logs having been seen are as follows: British steamer "Hampshire," January 24, in latitude 36° 17′ N., longitude 58° 36′ W.; British steamer "Picqua," January 27, in latitude 36° 40′ N., longitude 56° 25′ W.; German bark "Marie" was amongst the logs for several days, January 9 to 13, about latitude 38° N., longitude 50° to 60° W.; and the British steamer "Empire," February 22 and 23, in latitude 37° N., longitude 59° to 64° W. —*Pilot Chart for March.*

ICEBERGS AND FIELD ICE.—February is the month during which icebergs and field ice begin to be a source of great danger to transatlantic navigation, and this danger continues until the end of August. Back numbers of the *Pilot Chart* show that, although during January of last year only six reports of ice were received, and these only off St. Johns, Newfoundland, there were plotted on the *Chart* for March more than 100 ice-

bergs and masses of field ice, reported during the month of February. For this reason the transatlantic routes recommended this month are well to the southward, clear of the probable limit of drifting ice.

The ice which is brought down by the Labrador current during the spring and summer months consists of field or floe ice, which is formed on the surface of the sea during the polar winter, and of icebergs, gigantic masses which break from the glaciers along the coasts of Greenland. With the exception of some field ice which gets into the gulf of Newfoundland through the straits of Belle Isle, this ice is all carried to the southward, past the eastern coast of Newfoundland, and is liable to be encountered this month off the Grand banks as far south as 42° N. latitude, between the 42d and 52d meridians. A glance at the record of losses and casualties caused by ice last year on the North Atlantic calls attention very forcibly to this class of dangers: several vessels sunk by collision; others caught in heavy field ice, driven ashore, or otherwise damaged and delayed; many steamships reaching port with plates stove, rudders carried away, or blades of propeller gone. It is recommended to make free use of the thermometer, although experience shows that too much reliance should not be placed upon it.

Experiments made in recent years show that warning may often be obtained by means of the echo thrown back from the surface of an iceberg when a vessel's whistle is sounded, or any sharp noise is made, and apparatus has been invented to utilize the echo to determine direction and distance of the ice. No possible precaution should be neglected, especially during snow or fog, but the safest course of all is to take a southerly route, well clear of the probable ice limit.

Icebergs have been reported off the Grand banks with a height of more than 200 feet above the surface of the sea, and from the known depth of flotation of solid ice, such a berg must ground on the Grand banks, there to remain as a new and unchartered island until it dissolves sufficiently to be drifted further to the southward, and into the Gulf stream, where it rapidly melts and disappears. A berg just clearing the bottom of the sea at the

100-fathom curve would have only 100 or 120 feet above the surface: indeed, a solid block of ice is even more deeply immersed. There can be no doubt that the formation of the Grand banks is partly due to the masses of sand and soil brought down by icebergs during past ages and deposited where the bergs are melted by the warm waters of the Gulf stream. Were it not for this great warm current, ice would be a source of danger much further to the southward. The ice in the North Atlantic during the northern summer cannot be compared either in quantity or size with that which is brought up from the Antarctic zone into the South Atlantic, between the Falkland islands and the cape of Good Hope, during the summer months of the southern hemisphere. Thus one mass of ice which was reported by twenty-one ships from December, 1854, to April, 1855, from 44° S., 28° W., to 40° S., 20° W., was about sixty miles long and forty miles broad, with an elevation above the surface of the sea of fully 300 feet.—*Pilot Chart for January.*

THE APPLICATION OF PHOTOGRAPHY TO METEOROLOGY.—President Janssen, of the French Academy of Sciences, spent the first week of last October at the observatory directed by Mr. Vaussenat, on the summit of Mount Midi, one of the peaks of the Pyrenees, and, with the assistance of an expert photographer, Mr. Lamazouère, took photographs of the various atmospheric phenomena. The observations were made to throw light upon his studies on the elective absorption of oxygen, and the results are given in a paper before the Academy,* from which the following abstract is taken.

A series of photographs was taken at sunrise, October 4th, which shows the general view of the Pyrenees as seen from the observatory. At first the layer of clouds, almost continuous, occupied the valleys and extended from the ocean to the eastern part of the mountain range. The sun rising produced an effect on the clouds which caused them to rise. Very often warm currents of air pierced the stratum of clouds and carried away the nebulous matter, and small flakes raised themselves from the

Comptes Rendus, T. CV., p. 1164, December 12, 1887.

body of the clouds, assuming the most singular and fantastic forms. At the same time the general stratum of clouds rises, and the Pyrenees chain presents the appearance of a stormy sea, in which only the highest peaks emerge and form islands.

These phenomena are followed by others very interesting to the meteorologist. The clouds dissipate under the action of the sun's heat, or rise and form higher strata, or they mix into a jumbling mass and envelop the peaks and cut off the view. In the production of these phenomena part is taken not only by the meteorological conditions of the locality in which they occur, but also by the foreign elements which the wind brings and which exercise such a great influence on meteorology. An instance of this action was observed at Mount Simla, one of the peaks of the Himalayas, in 1868. During the month of December the atmosphere was quite calm. The dryness was extreme. Meat never tainted, and bread gave electrical manifestations at the touch. The action of the sun on the atmosphere in this condition had a remarkable clearness and regularity. The little vapor emitted by the vegetation of the valleys was condensed by the sun and formed a light cloudy layer on the ground. At sunrise this layer of clouds raised itself a little, and penetrating in the dry air, dissipated rapidly. Nevertheless, the hygrometer detected its presence in the air. At the setting of the sun these vapors re-formed and regained the bottom of the valleys, to again go through the same manifestations the next day.

This regular regime ceased in January. Then the winds brought from the Indian ocean torrents of aqueous vapor, and all the phenomena were unsettled. Then commenced the great rain storms of which the rest of the world has no idea.

To analyze the new atmospheric state, it is necessary to know exactly the importance of the foreign factors which enter to modify the local conditions.

A complete series of photographs, judiciously taken, ought to furnish, in connection with meteorological observations, some valuable elements for discussion.

The author recommends the continuance of Mr. Vaussenat as director of the observatory on Mount Midi, which is admirably

situated for studies of this kind, and regrets the discontinuance of the mountain stations of the United States Signal Service, where such observations could be carried on with good results.

In conclusion the author thinks that photography will make meteorology an independent science, which will be studied for itself, and that it will bring to it varied and valuable elements of discussion;—

1st. In giving together the different causes of the phenomena which can be compared and discussed, thus giving quite a new value to the observed meteorological elements.

2nd. In permitting, in particular cases, and by the employment of appropriate methods, the measurement of distances, heights, and dimensions of clouds, meteors, etc.

3rd. In opening to study all the ways of photometric measure of the light of the fixed stars in their relation to the atmosphere.

4th. In bequeathing to the future some useful documents which may show the starting point and progress of the science.

A. L. M.*

SUBMARINE OIL SPRINGS.—With the *Pilot Chart* for November last, there was issued a statement relative to the possible existence of submarine oil springs, as indicated by various reports received from shipmasters on the Atlantic and in the Gulf of Mexico. Mention was made, in this connection, also, of a well-known spot near Sabine Pass, on the Gulf coast, called the "Oil pond," where small vessels run in and anchor during heavy weather, the water being there comparatively smooth owing to a quantity of oil, or oily mud, which rises to the surface. It was also stated that no such reports had been received from the Pacific coast. Since the publication of this article, however, and as a result of the interest elicited by it, several reports have been received, and these are published herewith as a matter of general interest.

The attention of this office was first called to a letter from

*In the February number of this JOURNAL, the Notes on *City Air* (p. 484) and the *Action of Frost on Rocks* (p. 485), were due, as are the above, to Mr. A. L. McRae. They were attributed by oversight to Mr. Rotch.

Mr. Thos. K. Griffin, of the *Guide* office, San Francisco, published in the *New York Maritime Register*, December 21, in which he states that several submarine oil springs exist on the Pacific coast. The most pronounced is off what is known as "Coal Oil Point," about 1¼ miles west of Goleta and 10 miles west of Santa Barbara. Mr. Griffin has also kindly supplied information from several masters of vessels who have cruised in these waters, and their reports are so clear and consistent as to leave little room for doubt of the existence of such submarine oil springs off that coast.

Captain Van Helmes, American steamship "Los Angeles," states that, when a vessel passes through the region of the spring mentioned above, the smell of oil is so strong as frequently to cause nausea among passengers and crew, and in certain spots the oil can be distinctly seen bubbling up on the surface.

Captain Wallace, American steamship "City of Chester," Captain Ingalls, American steamship "Santa Rosa," and Captain Alexander, American steamship "Queen of the Pacific," testify that there are other similar springs on the Pacific coast, though not so pronounced as the former. Captain Ingalls gives the position of the large spring as follows: Latitude 34° 22′ 30″ N., longitude 119° 53′ W., distant 8 miles W. by S. ½ S. (*magnetic*) from Santa Barbara light. Captain Wallace locates it about 18 miles west of Santa Barbara, and states that the surface of the ocean is frequently covered for miles with the oil. He has also seen oil floating on the water to the north of Cape Mendocino, from 3 to 5 miles off shore, and thinks there is another spring there. Captain Plummer, American steamship "Gipsy," who has sailed 17 years in these waters, confirms the above statements, and says the belt of oil above Santa Barbara can be seen the darkest night when sailing through it.

A very full and interesting statement has also been received from Captain Goodall, of the Pacific Coast Steamship Company, who refers to the fact that Goleta Point is known to masters of steamships as "Coal Oil Point" on account of the oil abreast of it rising from the bottom of the sea. On a calm day

the water is covered for miles with oil, bubbles of which can be seen rising to the surface and spreading over it. Although it does not seem to smooth the water like animal oil, yet, on a windy day, you can see a smooth slick of oil on the surface. This spot is so well known by shipmasters that the smell of the oil is used as a guide in foggy weather, the petroleum smell being so strong that a captain can never mistake his position when off that point. Captain Goodall states, also, that he has noticed a small flow of oil from the bottom of the sea off Cojo Point, near Point Conception, but there the amount of oil is very small. It cannot be seen bubbling up from the bottom, but is often visible on the surface, the odor being very perceptible.

Bitumen is known to be generally distributed through the coast ranges to the southward of San Francisco, and petroleum wells and tar springs have been found at places. It seems probable, therefore, that the oil-bearing strata crop out here and there at the bottom of the sea off the coast, or else that the oil escapes through the crevices in the overlying strata and rises to the surface. Such submarine oil springs are known to exist at certain other places—the Bay of Cumana, Venezuela, for example, where petroleum rises and spreads upon the surface; and it is said that off the Island of Trinidad, West Indies, there are submarine volcanoes which occasionally boil up and discharge a quantity of petroleum.—*Pilot Chart for March.*

ABERCROMBY'S "WEATHER."*—This book is designed for intelligent readers who are unfamiliar with modern meteorology, to whom its purpose is to teach the inductive side of the science, with more especial reference to its use in forecasting the weather. The author has the qualities of a born teacher—clear and accurate statements, picturesque and graphic language, and a logical order of arrangement. He has, moreover, a happy way of applying apt and familiar analogies, which enable his readers to get clear ideas of what it would be hard to convey otherwise.

*International Scientific Series: "Weather," a Popular Exposition of the Nature of Weather Changes from Day to Day. By the Hon. Ralph Abercromby, F. R. Met. S., etc. New York: D. Appleton & Co., 1887.

To adapt the book still farther to the needs of readers unfamiliar with the subject, it is divided into two parts, the first elementary, and the second more advanced; the latter, however, not so abstruse that any educated reader need be deterred by the name; any such reader will have no difficulty in understanding it.

It is fortunate that this number of the International Series has fallen into Mr. Abercromby's hands, for the reasons just stated, and also for the reason that the author is unusually well prepared to treat the subject inductively. He has for many years been making a study of this side of the subject, and his numerous publications on various incidental features have already made him well known to meteorologists. The book is packed full of information from beginning to end, and no one can read it attentively without becoming fairly familiar with the present state of the science so far as it is empirical. The deductive the author only barely alludes to from time to time. It is much more difficult, and is not adapted to popular presentation. The deductive part of meteorology is within the reach of every one who remembers his college mathematics and physics, and if such readers will pass from Mr. Abercromby's book to Professor Ferrel's "Recent Advances in Meteorology," they may have the satisfaction of knowing that they have acquired the most that the science has to offer. Mr. Abercromby is not only inductive in his book; he is also inductive in his way of thinking. This leads him to neglect and undervalue the results of mathematical and physical study so far as to occasionally leave in the well-informed reader a feeling of dissatisfaction with his conclusions—a feeling which is not so much caused by faults of the book as faults of the exclusive use of one method of study in a science where both methods are necessary.

The reader will find here a great deal which he could find elsewhere only in the publications in which they appeared as original studies, and many of the results are the author's. The latter are in a general way indicated in the preface, and specifically they are sometimes pointed out in the foot-notes or in the text. It would, perhaps, have been better to have always indi-

cated them, as they have not all as yet been generally accepted, and the public for which the work is professedly written is those unfamiliar with the science, and therefore unable to distinguish between what is generally accepted and what is as yet the opinion of the author only. It is somewhat unfair, perhaps, to criticise a book because its author has himself done so much of the work on which its conclusions are based, and such a criticism can receive its only justification when the book is, like this one, intended for the general public. An introduction to a science should contain nothing which is still in controversy unless the state of the controversy is so fully laid before the reader that he can draw his own conclusions.

There is much in the book which will be of interest to professional meteorologists. The author is very happy in his nomenclature, and many of his names are worthy of general adoption. He has also treated of some subjects with unusual fullness and ingenuity, such as the explanation of popular prognostics, the studies of special isobaric forms (such as secondaries, V's, wedges, etc.), and those of non-isobaric phenomena. The chapter on clouds is full and suggestive, and we commend especially the discussion of what are here called "surges." The treatment of diurnal changes in the isotherms is very clever. The chapter on local variation of weather opens a field of study of very great interest and within the reach of every one. The study of types of weather is especially full of interest, and suggestive. But for new and unsolved problems the reader is not left to suggestion alone. Attention is directed in many places to problems which still await solution, but these are too numerous to specify here.

The work is designedly international in scope, and, though much the largest part is especially drawn from English and European experience, American meteorology receives a good deal of attention, as do Australian and Indian, while occasional references are made to other parts of the world. The author has recently made a long journey, during which he seemed to have devoted himself to the collection of meteorological information. We fear, however, that in America he may have met a

humorist of the Mulhatton type, for he tells us that an effect of freezing by our blizzards is to cause the sufferer to strip himself of his clothing—an effect which the writer has never heard of, though he was born and bred on the outskirts of the blizzard region and has frequently traversed it in all directions.

The book is unfortunately marred by typographical and other errors, few of which would, however, mislead the reader. Of the latter we may mention the following: On page 130, line 17 from bottom, for *West* read *East*. On the last line of page 185 a quarter of one degree is evidently meant. On page 449, line 5, *thousand* is probably meant for *hundred*. At the bottom of page 451 the reference to a German authority contains no less than four errors. These are unimportant defects, easily remedied in a new edition. The book as a whole is excellent, and deserves to be read by every one at all interested in meteorology. H.

Royal Meteorological Society.—The monthly meeting of this society was held on Wednesday evening, the 18th of January, at the Institution of Civil Engineers, 25 Great George Street, Westminster; Mr. W. Ellis, F. R. A. S., President, in the chair.

Messrs. C. H. Blackley, M. D.; H. E. Brameld; E. S. Bruce; W. Forrest; J. Groves, M. D.; C. Harrison, M. D.; G. C. Harrison; H. R. Haswell; R. Laing; H. J. Lloyd; H. T. H. Mead; C. Perks; W. R. Pike; J. L. Rushton, M. D.; and J. H. Walker, were elected Fellows of the Society.

The paper read was: "The Non-Instrumental Meteorology of England, Wales and Ireland," by Mr. G. M. Whipple, B. Sc., F. R. A. S., F. R. Met. Soc. This is a discussion of the observations of wind, cloud, thunderstorms, hail, snow, etc., made at the stations of the Royal Meteorological Society, during the eight years, 1878–1885, and published in the *Meteorological Record*. The S. W. wind is the most prevalent, and blows on the average 74 days in the year; the W. wind occurs almost as frequently, blowing 65 days. The least dominant winds are the S. E. and N., which occur on 27 days, and the N. E. on 32 days.

Thunderstorms are most frequent in the eastern and midland counties, and least frequent in the north of Wales.

After the reading of this paper the annual general meeting was held. The report of the council showed the society to be in a satisfactory condition, the number of Fellows being 522.

Mr. Ellis, in his presidential address, reviewed briefly the work and position of the society, remarking, that such a society, whilst unable to carry out expensive, original or experimental work, could yet act with great advantage in inciting volunteer workers throughout the country to united action, of which one recent example was the ready response to the request of the society for photographs of lightning, an excellent collection of which had been obtained, and which would shortly be exhibited; in addition to which arrangements were being made for the more systematic observation of thunderstorms. Referring to the question of sympathetic relation between sun spots and magnetism and meteorology, he thought that any complete treatment of the question in its meteorological aspect seemed to require that it should be dealt with in a much more comprehensive manner than before, for which purpose observations more completely covering the surface of the globe might be necessary, if indeed not necessary also for the solution of many other meteorological questions, the present meteorological stations being distributed over the earth in such isolated clusters. The attention given to synoptic charts was most important, but the general meteorological characteristics of places should also still continue to be studied. After remarking upon other matters, he laid before the meeting tables showing the monthly means of amount of cloud from observations made in three different series at the Royal Observatory, Greenwich, extending in all from 1818 to the present time. In concluding, Mr. Ellis said that at one time the science of meteorology seemed likely to form an exception to the general rule of advance, for more than any other it has required the united action of many workers, but the field of enquiry of late years opened out allows us already to talk of the new or modern meteorology, phrases typical of the advance achieved,

although the knowledge gained seems only to remind us of how much has yet to be done.

The following gentlemen were elected the officers and council for the ensuing year:

President.—William Marcet, M. D., F. R. S., F. C. S.

Vice-Presidents.—Francis Campbell Bayard, LL. M.; William Ellis, F. R. A. S.; Charles Harding; Richard Inwards, F. R. A. S.

Treasurer.—Henry Perigal, F. R. A. S., F. R. M. S.

Trustees.—Hon. Francis Albert Rollo Russell, M. A.; Stephen William Silver, F. R. G. S.

Secretaries.—George James Symons, F. R. S.; John William Tripe, M. D., M. R. C. P. Ed.

Foreign Secretary.—Robert Henry Scott, M. A., F. R. S., F. G. S.

Council.—Hon. Ralph Abercromby; Robert Andrew Allison, M. P.; Edmund Douglas Archibald, M. A.; Milliam Morris Beaufort, F. R. A. S., F. R. G. S.; Henry Francis Blanford, F. R. S., F. G. S.; Arthur Brewin; George Chatterton, M. A., M. Inst. C. E.; William Henry Dines, B. A.; Henry Storks Eaton, M. A.; Baldwin Latham, M. Inst. C. E., F. G. S.; Edward Mawley, F. R. H. S.; Charles Theodore Williams, M. A., M. D., F. R. C. P.

February Meeting.—The monthly meeting of this society was held on Wednesday evening, the 15th of February, at the Institution of Civil Engineers, 25 Great George Street, Westminster; Dr. W. Marcet, F. R. S., President, in the chair.

Mr. T. S. Ainge, Mr. J. C. Bell, F. R. G. S., Mr. C. A. Markham, Surgeon-Mayor S. Smith, Mr. J. T. Tibbles and Dr. J. Walther, were elected Fellows of the society.

The following papers were read:

1. "Electrical and Meteorological Observations on the Peak of Teneriffe," by the Hon. Ralph Abercromby, F. R. Met. Soc. The author made a trip to the Island of Teneriffe, in October, 1887, for the purpose of making some electrical and meteorological observations, and now gives some of the results which he obtained, which may summarized as follows: The electrical condition of the Peak of Teneriffe was found to be the same as in every other part of the world. The potential was moderately positive from 100 to 150 volts, at 5 feet 5 inches from the ground even at considerable altitudes; but the tension rose to 549 volts on the summit of the peak, 12,200 feet, and to 247

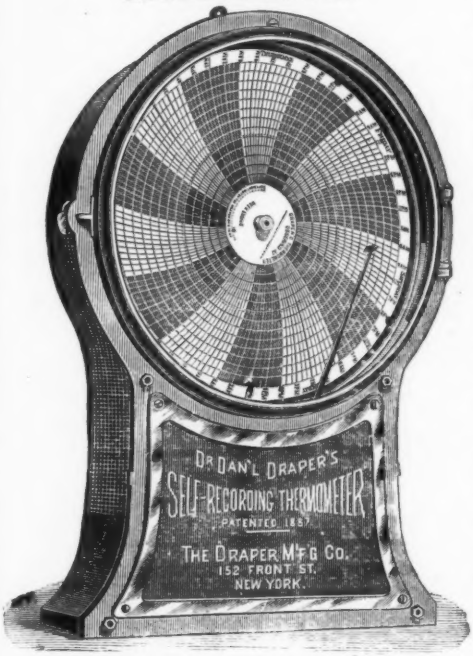
volts on the top of the Rock of Gayga, 7,100 feet. A large number of halos were seen associated with local showers and cloud masses. The necessary ice-dust appeared to be formed by rising currents. The shadow of the peak was seen projected against the sky at sunset. The idea of a southwest current flowing directly over the northeast trade was found to be erroneous. There was always a regular vertical successsion of air currents in intermediate directions at different levels from the surface upwards, so that the air was always circulating on a complicated screw system.

2. "Rainfall of South Africa, 1842-1886," by Mr. W. B. Tripp, M. Inst. C. E., F. R. Met. Soc. The author gives the rainfall statistics from all those stations situated in South Africa which possess records of 10 complete years and upwards. He remarks upon the chronological succession of wet and dry years, and the consecutive years above and below the mean; and also describes the seasonal distribution of monthly maxima, and the extent over which monthly rains prevail. He concludes by comparing the curves of rainfall with those of sun-spot energy.

3. "Some Methods of Cloud Measurements," by Mr. Nils Ekholm. As exact cloud measurements afford almost the only easily available means of determining motions in the upper regions of the atmosphere, the author describes some methods which seem to him likely to give the best results. He also details the plan adopted at the Swedish Polar Station, Cape Thorsden, in Spitzbergen, and at the Upsala Observatory, for determining the direction and angular velocity of the clouds, and for making direct measurements of the height and absolute motions of the clouds.

DRAPER'S SELF-RECORDING THERMOMETER.

DESCRIPTION OF THE INSTRUMENT AND DIRECTIONS FOR ITS USE.



SIZE 14 BY 20 INCHES.

Protected by Letters Patent in the United States, Canada, Great Britain France, Germany, Austria, Hungary and Belgium.

STANDARDIZED AND WARRANTED.

MANUFACTURED BY THE
DRAPER MANUFACTURING COMPANY,
152 FRONT STREET, NEW YORK CITY.

This thermometer gives a permanent and continuous record in ink of the temperature. The chart indicating hours of the day and days of the week, gives the degrees of temperature from 20° below zero to 110° above. All instruments are accurately adjusted and warranted. The record is easily read and absolutely correct. Sold by the leading instrument dealers and opticians throughout the United States and Canada, and by

The DRAPER MANUFACTURING CO.,

Owners of the United States and foreign patents, 152 Front Street, New York.

BAILEY'S 30 INCH COSMOSPHERE

With metal coverings and constellation figures is worth "all the Globes and Tellurians ever constructed for making plain the causes of Celestial phenomena." "The constellations and their motions are shown in correct position and not reversed as in the ordinary Celestial globes."

"The changes of seasons and varying length of days are clearly shown." "An indispensable help in teaching Astronomical facts."

Correspondence solicited with one *good teacher* in each State who has the ability to sell goods and time to devote to it. Address

MICHIGAN SCHOOL FURNITURE CO.,
Northville, Wayne Co., Mich.

STANDARD THERMOMETER.

LEGIBLE.

5 inch Dial.

$3.00.

ACCURATE.

8 inch Dial.

$4.00.

(Metallic.)

Special Thermometers for Meteorologists with or without Telemeter attachments.

AGENTS:

THE FAIRBANKS SCALE HOUSES

In the principal cities of the United States.

Medical and Surgical Sanitarium, Battle Creek, Michigan.

THE LARGEST SANITARIUM IN THE WORLD.

This Institute has for many years enjoyed an increasing patronage from all parts of the United States and Canada, during which time more than 10,000 Patients have enjoyed the benefits of its unrivaled facilities for the treatment of all forms of Chronic Diseases, including special departments for the Eye, Ear, Throat, and Lungs, together with diseases peculiar to each sex. Every Remedial Agent of Known Value is Employed.

The managers have spared no expense to perfect the appliances of the Establishment to the highest degree, and regardless of cost; and a personal acquaintance with the leading Sanitariums of both this country and Europe, enables us to say that no where else in the world can the invalid in search of health find so great an assemblage of means and appliances for combating disease as found here.

Address, for circulars and further information, inclosing stamp,

SANITARIUM, Battle Creek, Mich.